March 1947

ET-235

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

INEXPENSIVE REPLACEMENT ELEMENTS FOR LABORATORY HOT PLATES

By Harold W. Rusk
Division of Insecticide Investigations

The hot plates generally available from supply houses do not fill the unusual needs of some laboratories, being limited either by physical size or temperature range. Inexpensive replacement elements, which are available in 600-and 1000-watt sizes, may be used as versatile heating units for custom-designed hot plates. These elements consist of two equal arms wound with ribbon resistance wire over a mica core, enclosed in sheets of mica and connected to form a waferlike unit with leads at the end of each arm coil and at the common center. At low heat both arms are connected in series, at medium heat only one arm is across the line, the other arm being dead (this causes uneven surface temperatures), and at high heat both arms are across the line in parallel.

A hot plate that would accommodate six 500-ml. Erlenmeyer flasks, and produce a temperature sufficient to reflux 50- to 100-ml. samples of benzene solutions was needed. Since no hot plate of proper size and heat range could be found in the catalogs, it was decided to construct a unit for this purpose.

The framework of the hot plate consisted of 20-gage sheet metal for the front, back, and sides, 1-by 1-inch angle iron for corner posts, and 3/4-by 3/4-inch angle iron for the heater support rails. The support rails were riveted on the inside of the front and back pieces about 1/2 inch below the top. The heating unit was constructed from a piece of cold-rolled steel 3/16 by 5 by 36 inches for the top, three 6-inch, 3-heat replacement elements for the heat source, and a base or backing plate of Transite (an asbestos-cement insulating board) of the same dimensions as the top. Each element was separated by cutting the mica separator strip at the end having the two leads. The mica at the center-tapped end was then cut and the lead cut off, with care not to cut the wire connecting the two arms. Each element was spread out and the distance between the two arms adjusted to about 1 inch by pulling the connecting wire slightly. After the three elements had been treated as above, they were then placed in position on the Transite base, the leads were pulled through their holes as shown in figures 1 and 2, and all spaces not occupied by the elements were filled with asbestos paper thick enough to keep the elements in place and prevent buckling. The resistance wire connecting the arms of each element was insulated with asbestos paper and the entire heating unit placed in position on the support

rails and drawn up tightly with the stove bolts, as shown in figure 2, after which the sides and corner posts were bolted on, switches and terminal block secured in place, and the wiring done according to the diagram in figure 3. As wired the hot plate has an output of 450 watts with a current consumption of 3.9 amperes.

The design of this hot plate permits using each element individually through its respective switch. However, many variations are possible. If a higher plate temperature is desired, a few turns may be removed from each arm of each element, or, conversely, if a lower temperature is desirable, fixed resistors may be placed in series with each element. A suitable variable resistor could also be placed in the main lead to provide a wide range of temperatures. By using 4-position rotary switches and utilizing the center-tapped leads, the hot plate can be changed to a 3-heat unit similar to the usual laboratory hot plate. However, consideration must be given to the current consumption of such an arrangement, since the three elements on high heat (1800 watts) would draw a current of about 16 amperes.

Variation of the described design proved practical in the construction of a 2-heat unit, 10 1/2 by 13 inches, made of materials similar to those in the 450-watt unit. Two heating elements, spread apart and placed one behind the other to give uniform distribution of heat over the working surface, were employed in this hot plate and controlled by a double-pole, double-throw knife switch to obtain two operating heats (300 and 1200 watts). In the first, or low, heat the two arms of each element are in series and the two elements in parallel, while at high heat each arm of each element is in parallel.

This hot plate has proved satisfactory for general laboratory use such as reducing the volume of organic solvents or boiling down aqueous solutions. Its total cost is about $10.

MATERIALS NEEDED FOR A 450-WATT PLATE

Heating unit:
   Top--1 piece 3/16 x 5 x 36 inches, steel plate, drilled and countersunk to take 3/16-inch stove bolts
   Elements--3 replacement units for 6-inch, 3-heat stove, 600-watt
   Base--1 piece Transite, 3/16 x 5 x 36 inches, drilled as in figure 1

Frame:
   Sheet-metal, 20-gage--2 pieces 6 x 36 inches (front and back)
                         2 pieces 5 x 6 inches (sides)
   Angle iron, 1 x 1 inch--4 pieces 1 x 6 inches (corner posts)
               3/4 x 3/4 inch--2 pieces 3/4 x 35 1/2 inches (heater unit supports)

Switches--3 recessed snap switches
Appliance cord--8-ft. asbestos-covered cord with receptacle plug
Terminal block--1 piece Transite 2 x 3 inches
                2 small metal angles

Bolts, nuts, washers, and rivets as needed

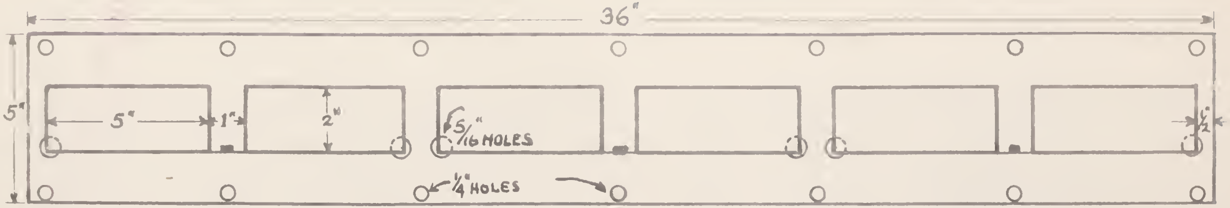

Figure 1.— Diagram of Transite base showing location of elements and necessary holes.

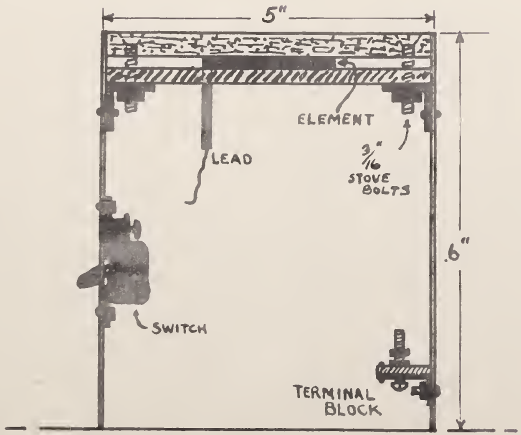

Figure 2.-- End section of hot plate showing location of heater unit, switches, and terminal block.

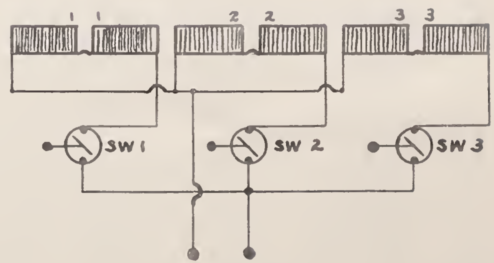

Figure 3.-- Wiring diagram for 450-watt hot plate.